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Abstract

A method of controlling the temperatures within individual zones of a centrally temperature controlled multi-zoned dwelling wherein the temperature in each zone is separately controlled by detecting the temperature of a heat transfer fluid within each zone, providing a signal proportional to the detected temperature in each zone to the central temperature controller which regulates the fluid flow to each zone in accordance with the fluid flow required to achieve a set point temperature for each zone.

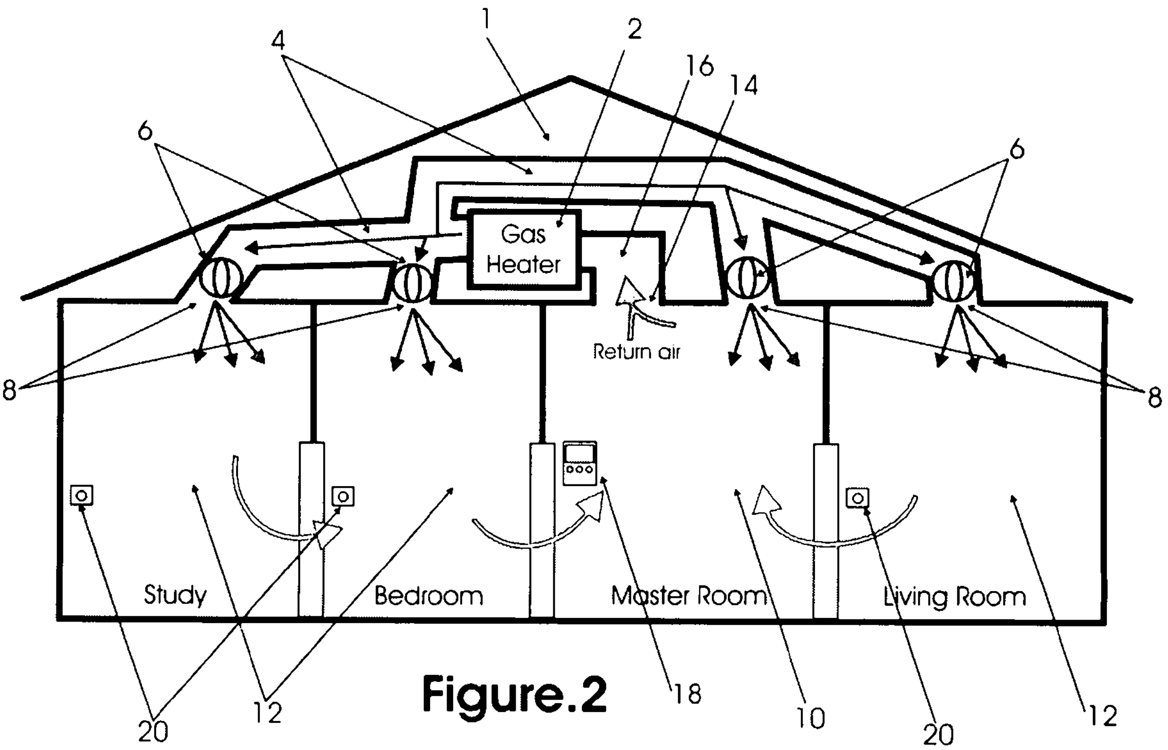

Figure.2

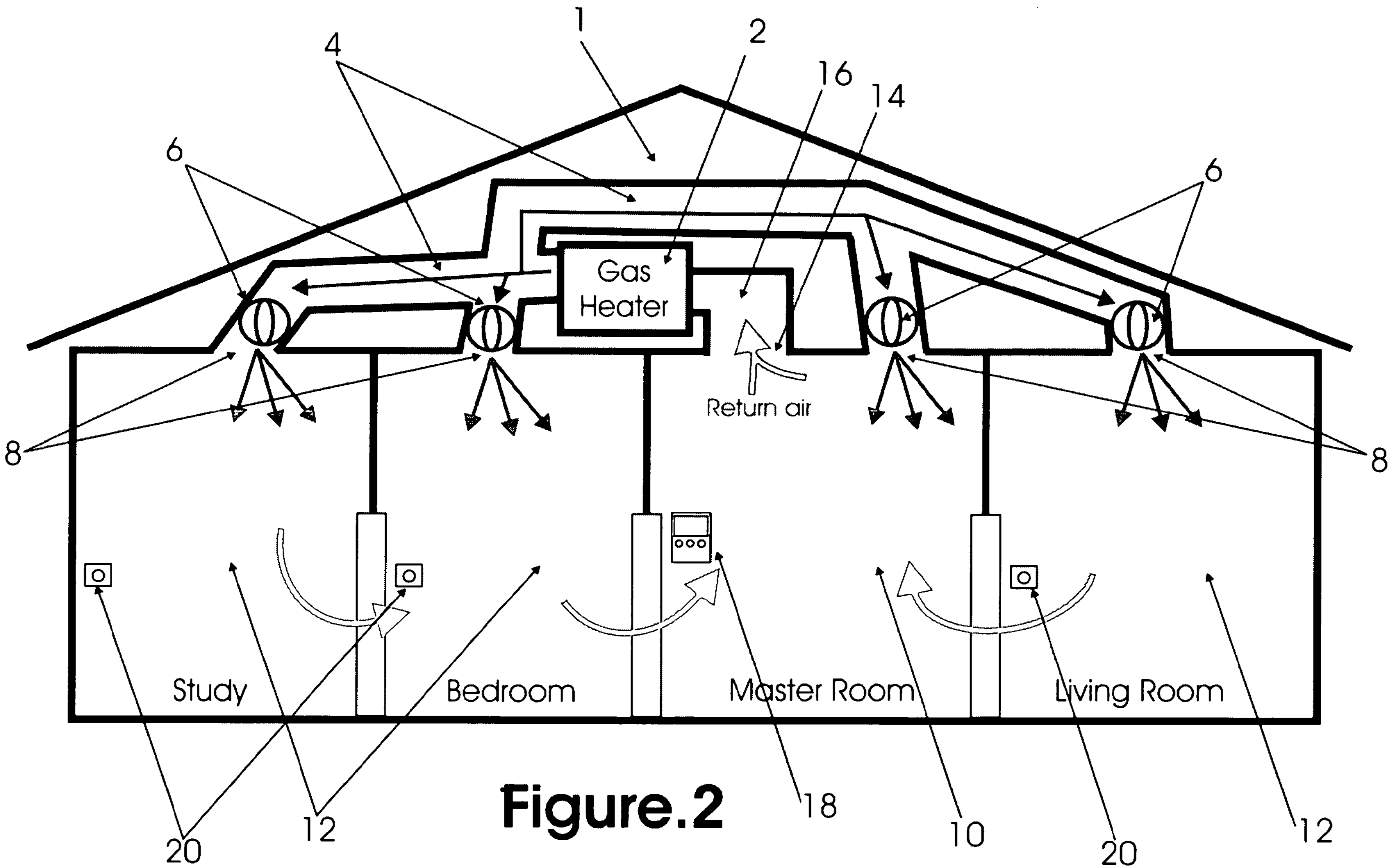
1
2
4
16
14
6
6
Gas Heater
Return air
8
8
Study
Bedroom
Master Room
Living Room
20
12
18
10
20
12

Figure.2

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Regulation 3.2

AUSTRALIA
PATENTS ACT 1990

COMPLETE SPECIFICATION

FOR A INNOVATION PATENT

ORIGINAL

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Invention Title: "HEATING OR COOLING CONTROL"

Details of Associated Provisional Application No: 2006902225 dated 7th April, 2006

The following statement is a full description of this invention, including the best method of performing it known to the applicant.

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AUSTRALIA

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COMPLETE SPECIFICATION

Invention Title:

Heating or Cooling Control

The invention is described in the following statement:

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Technical Field

The present invention relates to control systems for space heating or cooling of dwellings. In particular, this invention is concerned with the control of dwellings divided into multiple zones for the purpose of space heating/cooling, and the control of the space heater/cooler with respect to the supply of temperature controlled air to those zones

Background Art

Throughout this description and the claims which follow, unless the context requires otherwise, the word "comprise', or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgement or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

For convenience, the following description will be with respect to heating only but it will be understood that the present invention is equally applicable to cooling systems.

Space heating of a dwelling in cold climates is generally achieved with the use of a central heating station and a distribution system, which distributes heat to the interior parts of the dwelling. The central heating station can be fuelled from several energy sources including gas, oil, electric and electric heat pump. Typically, heat is distributed to the interior of the building by means of fluids, either via the air within the house or by heated water distribution systems. For the purposes of the following description only, which is not limiting upon the scope of the current invention, the central heating station will be a gas fuelled space heater and the heat will be described as distributed by re-circulated air.

It is desirable to divide the dwelling into zones when space heating. When the climate in winter is not extreme, as it is in most parts of Australia, it is not necessary for thermal comfort to keep the entire dwelling uniformly heated. It is common practice to divide the dwelling into zones which can be independently heated, or not, from the central heating unit. In practical terms, the zones in which people are present would be kept heated, whereas zones in which no-one is present would be turned off. The saving in energy cost by heating only those areas required to be heated rather than the entire dwelling is obvious.

In the present description, the air within the dwelling is the transfer fluid, and the means for facilitating transmission of heated air is a system of ducting whereby the heated air from the central heater is transferred to each of the zones and distributed via ceiling or floor mounted registers into the room(s) of the respective zones. The air so distributed then travels through the zone transferring heat to that zone before returning to the central heating unit via a return register generally located in the zone referred to as the master zone. The ducting to each of the zones is equipped with a valve or valves, which can be remotely set to be either open or closed. If heating is required in a specific zone, the system controller will set the ducting valve for that zone to the open position, thereby allowing heated air to flow to that zone. If heating is not required in a zone, the ducting valve will be set to closed, thereby preventing heated air from flowing to that zone.

In the prior art system as described, overall control of the heater is achieved be means of a controller, the temperature sensing elements of which are located in the master zone, and generally in close proximity to the return air register in the master zone. It is essential that the return air register is located in the master zone, thereby requiring all heated air delivered by the central heating unit to pass through the master zone to reach the return air register.

While such a system and its controls allow for whole of dwelling heating (all zones turned on), or partial heating (not all zones turned on), the temperature anywhere in the dwelling is determined by the temperature set by the controller for the master zone, since this is the only area where temperature is measured and compared with the set point of the controller. There is no provision, nor any means of controlling, a requirement to have different temperature set points for each of the zones, other than turning zones on or off altogether.

An ability to set different temperatures for different zones would provide advantages in terms of thermal comfort and energy usage for the occupiers of the dwelling. The need for different temperatures can be for diverse reasons such as activity levels in different zones and physiological differences between the occupiers of zones. In control systems available until the present, it has been necessary to either compromise on the differing requirements for thermal comfort, or to set the thermostat to the highest temperature requirement for the zones and allow lower temperatures to be achieved by wasting heat via ventilation of zones.

If the temperatures of individual zones could be set and controlled independently of each other, optimal comfort could be achieved for the occupants within different zones while using the least rate of energy consumption consistent with achieving thermal comfort for those occupants.

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Disclosure of Invention

In one aspect the present invention provides a method of controlling the temperatures within individual zones of a centrally temperature controlled multi-zoned dwelling wherein the temperature in each zone is separately controlled by detecting the temperature of a heat transfer fluid within each zone, providing a signal proportional to the detected temperature in each zone to the central temperature controller which regulates the fluid flow to each zone in accordance with the fluid flow required to achieve a set point temperature for each zone.

Preferably, the heat transfer fluid is fan-forced air.

In a preferred method, the required temperature controlled fluid to each zone is achieved by opening or closing or by proportional positioning of valves in respective fluid flow passages to the zones.

In another aspect the present invention provides a system for controlling the temperature within individual zones of a centrally temperature controlled multi-zoned dwelling, wherein each zone is equipped with a thermostatic controller and means for controlling a temperature set of a fluid flow, such that the fluid flow is regulated to each zone in accordance with a signal from a respective thermostatic controller in each zone to the central temperature controller, said central temperature controller controlling the fluid flow to each respective zone to achieve the set point temperature in each zone.

In a preferred method, temperature controlled fluid flow to each zone is by means of, say, proportionally positionable valves, or by "on" and "off" modulation of two position valves in respective fluid flow passages to the zones.

Brief Description of Drawings

The present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic of a domestic dwelling divided into zones for heating, with a conventional control system; and

Figure 2 is a schematic as in Figure 1 but incorporating an embodiment of the present invention; and

Figure 3 is a control logic flow diagram typical of the system illustrated in Figure 1; and

Figure 4 is a control logic flow diagram of the system of Figure 1 but incorporating an embodiment of the present invention.

Best Modes

In Figure 1, a gas space-heating unit 2 is shown fitted within the ceiling space 1 of a domestic dwelling. The space heater 2 delivers heated air through delivery ducting 4 to delivery registers 8 located in each of the subsidiary zones 12 or master zone 10 into which the depicted dwelling has been divided for the purpose of heating control. Heated air passes through the zones as required and transferring heat to the surroundings, before entering the return register 14 and returning to the heater 2 through the return air duct 16. The return register is located in the master zone space 10, as is the master controller 18. The master controller 18 is generally located in close proximity to the return register 14

When an installation has been made with facility for zoning, each of the delivery ducts 4 has installed a duct valve 6 which can be turned from the off to on position, and vice versa, under the control of the master controller 18.

When the system is in operation, the master controller 18 controls the rate of heating and rate of airflow through the heater 2 and ducting to maintain the temperature set-point at the position of the master controller. If the facility for zoning of the dwelling is installed, the master controller will turn each of the duct valves 6 to the on or off position, dependant on the instructions set by the occupant. For example, if heating is required in zones one and three, the duct valves in those zones will be set to open, while the duct valves in all other zones will be set to closed. In this condition, heated air will be delivered to zones one and three only, that air always returning to the heater via the return register in the master zone.

While the conventional means of control and zoning of Figure 1, described above, provides reasonable temperature control, and the ability to turn zones off in which no heating is required, there are a number of disadvantages which affect the comfort of the occupants and the cost of operation of the system.

High airflows must be maintained to avoid a considerable disparity in the temperature of the zones for which heating is required and the temperature in the master zone as controlled by the thermostat in master controller 18. This results in draughts in the zoned spaces and a corresponding degradation of the comfort of the occupants.

Temperatures are sensed in the master zone, rather than the zone space for which heating is required. There may be a considerable difference in temperatures between these locations depending on the heat loading of the zones. A single temperature setting at the master controller could easily result in temperatures that are too hot or cold in the heated zones remote from the master zone. For similar reasons, there may also be considerable temperature

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differences between the actual temperatures of heated zones, even though the same thermostat is controlling them all.

The temperature set point will generally need to be set to provide sufficient warmth in the coolest zone, notwithstanding the over-temperature discomfort likely to be caused to occupants in other zones. This results in higher energy consumptions of fuel in the heater over and above that actually required to achieve comfort for the individual occupants.

Superior overall comfort, and optimised energy consumption could be achieved if the temperatures of each zone could be individually controlled or turned off according to requirements.

The control system logic flow of a conventional control system of the type incorporated in Figure 1 is illustrated in Figure 3. A single controller 18 controls the entire system including the switching of zones. When operating, the logic flow at 30 tests the temperature at the single controller and compares the temperature to the set point of the controller. If the measured temperature differs from the set point by more than 0.5 degrees, commands are sent to the heater to either start, continue or stop heating until the measured temperature falls within the control band. The logic at 32 sets zones on or off as set by the operator allowing those zones set to be heated, but only ever to the temperature as controlled by the single controller 18.

In Figure 2, individual zone controllers have been installed within the same layout of dwelling. Air delivery and return to and from the space heater 2 is as above. Zone controllers 20 are installed in each of the subsidiary zones 12. In practical units, each of the zone controllers 20 is connected back to the master controller 18, with the master controller operating each of the duct valves 6.

In operation, each of the zone controllers 20 can be set to the temperature required for that particular zone or set to be turned off. The master controller will then control the duct valve associated with each zone, regulating the flow of heated air to each zone to minimise the difference between the temperature set point for each zone and the actual temperature in each zone.

In the system subject of the current invention illustrated in Figure 2, individual temperatures can be set within each of the zones. The master controller regulates the flow of heated air to each zone in proportion to the heating required to achieve the temperature set point of each zone. This regulation can be achieved by such methods as proportional opening of the duct valves to a position which just balances the airflow required to achieve the set temperature at the heat load of the zone, such position being the result of conventional feedback and control systems within the master controller. An alternative method of achieving the required average heated airflow is to frequently turn the duct valve to each zone on and off. In this configuration, the average flow of heated air is determined by the ratio of "on" and "off" time of the relevant duct valve 6, such ratio again being determined by conventional control and feedback means within the master controller.

An embodiment of the application of this control is illustrated in the control logic flow diagram of Figure 4. The logic at 40 tests the master controller 18 temperature against the master controller set point and switches the zone control for the master zone (zone 1) open or closed depending on the difference in temperature between measured and the set point. Continual testing of the controller temperature to the set point will result in periodic opening and closing of the zone 1 duct valve, thereby modulating the flow of warm air to zone 1 to achieve a mean temperature close to the zone 1 set point.

Logic flow at 44 determines which zones are to be tested according to the settings requested by the operator. For each zone required to be heated, the logic at 42 compares the measured temperature at each zone controller 20 with the set point for each individual zone. The controller then opens or closes the duct valve for each zone according to the difference in temperature between set point and measured temperatures for that zone. Continued operation results in periodic opening and closing of the duct valve for each zone thereby achieving a mean temperature for the zone close to the zone set point. The logic flow then loops to check the same parameters for each zone, thereby controlling the temperature of each of the zones for which heating is required to a temperature close to the set point of each zone by the periodic opening and closing of the duct valves associated with each zone.

The current invention thereby provides only the average airflow rate required for each zone to achieve the temperature set point for that zone. There is no more energy provided to heat the air than the minimum required to achieve a temperature set point. Each zone can have a different temperature set point without interfering with the actual temperature in any other zone. There is no longer a requirement to pass large airflows back to the master zone in order to ensure return temperature sensing at the return air register, with corresponding reductions in draughts within the dwelling.

It will be understood by the addressee that the foregoing description is not limiting upon the present invention and that numerous modifications or variations are possible without departing from the spirit or scope of this invention.

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CLAIMS:

1. A method of controlling the temperatures within individual zones of a centrally temperature controlled multi-zoned dwelling wherein the temperature in each zone is separately controllable by detecting the temperature of a heat transfer fluid within each zone, providing a signal proportional to the detected temperature in each zone to the central temperature controller which regulates the fluid flow to each zone in accordance with the fluid flow required to achieve a set point temperature for each zone.

2. A method as claimed in claim 1, wherein the heat transfer fluid is fan-forced air.

3. A method as claimed in claim 1 or 2, wherein the required flow temperature controlled fluid to each zone is achieved by opening or closing or by proportional positioning of valves in respective fluid flow passages to the zones.

4. A system for controlling the temperatures within individual zones of a centrally temperature controlled multi-zoned dwelling, wherein each zone is equipped with a thermostatic controller and means for controlling a temperature set of a fluid flow to each zone, such that the fluid flow is regulated to each zone in accordance with a signal from respective thermostatic controllers in each zone to the central temperature controller, said central temperature controller controlling the fluid flow to each respective zone to achieve the set point temperature in each zone.

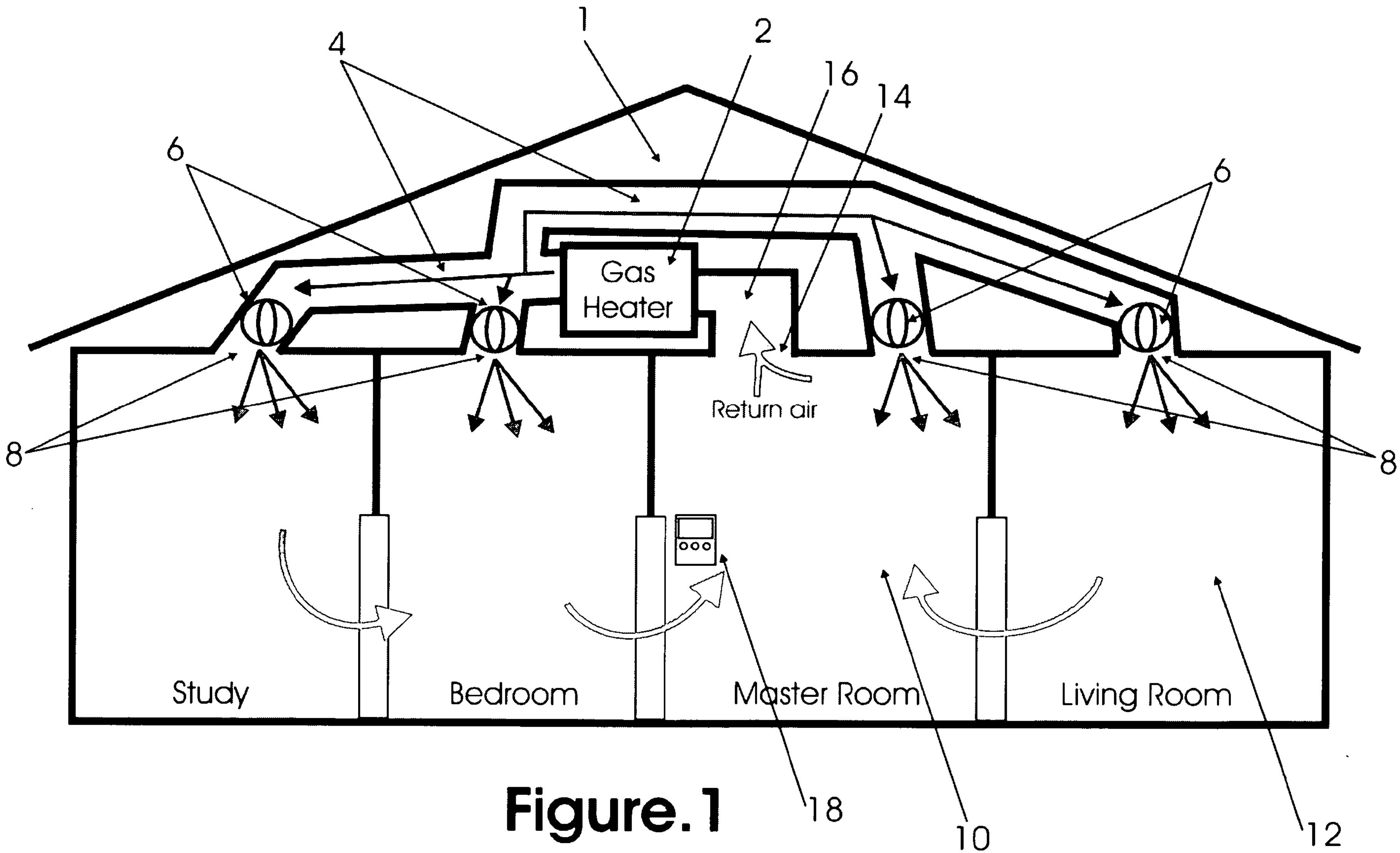
5. A system as claimed in claim 4, wherein the flow of temperature controlled fluid to each zone is by means of proportionally positionable valves, or by opening or closing of two position valves in respective fluid flow passages to the zones.

6. A system as claimed in Claim 4 or 5, wherein the heat transfer fluid is air.

7. A method of controlling the temperatures within individual zones of a centrally temperature controlled multi-zoned dwelling substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

8. A system for controlling the temperatures within individual zones of a centrally temperature controlled multi-zoned dwelling substantially as

hereinbefore described with reference to Figure 2 of the accompanying drawings.


1
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16
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Gas Heater
Return air
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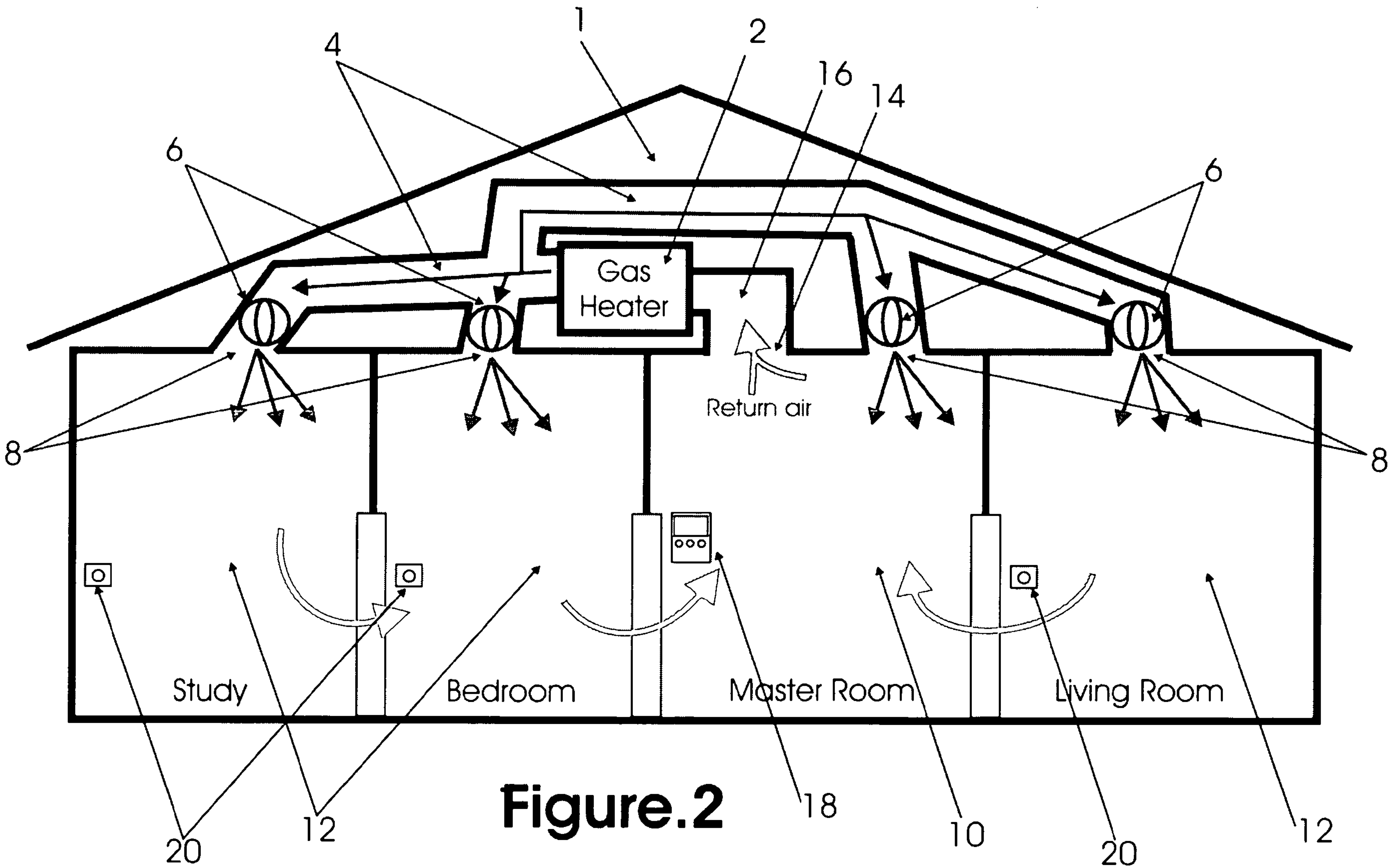
Study
Bedroom
Master Room
Living Room
18
10
12

Figure. 1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Bedroom
Master Room
Living Room
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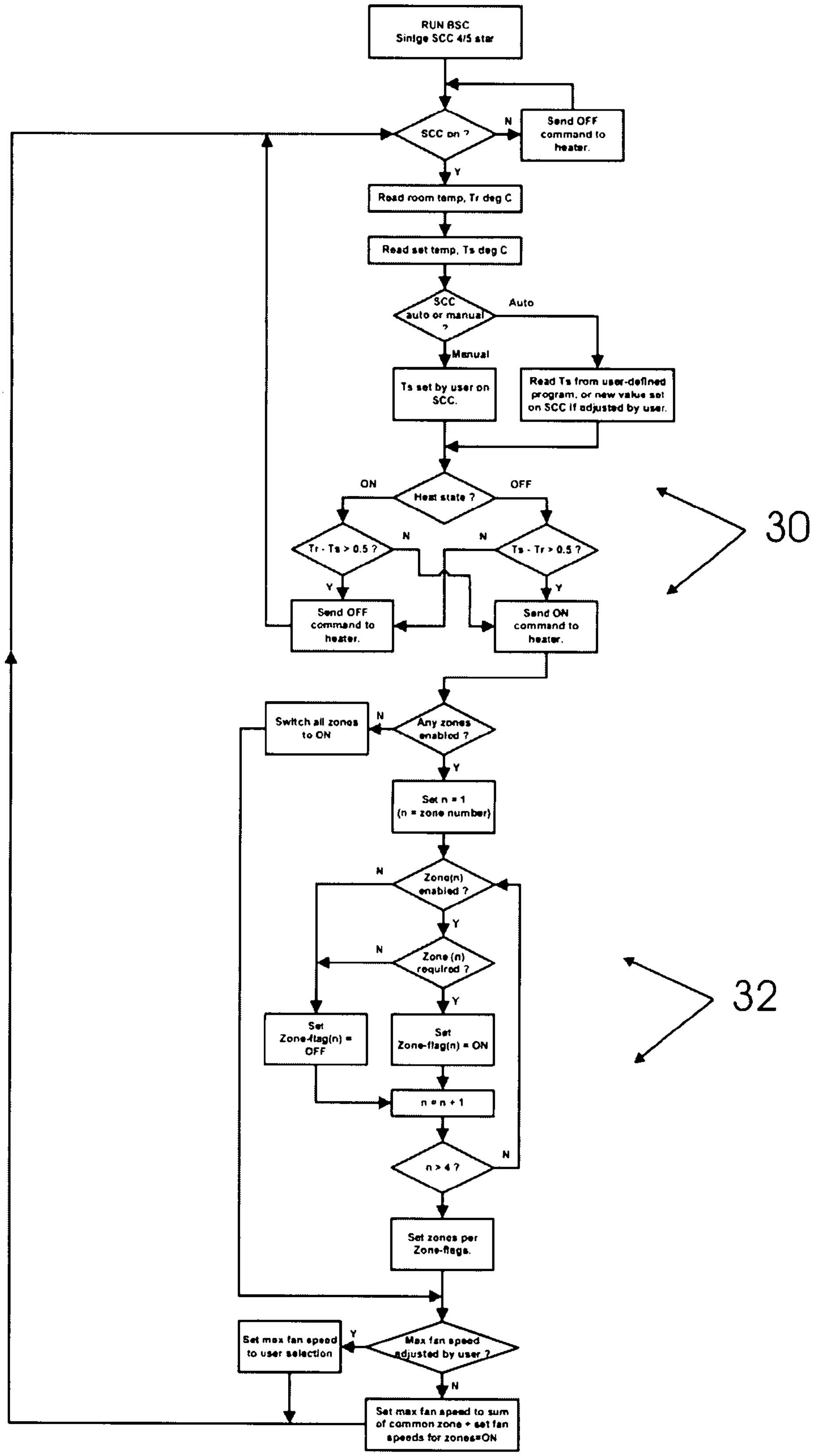
Figure.2



RUN BSC
Sinlge SCC 4/5 star
SCC on ?
N
Send OFF command to heater.
Y
Read room temp, Tr deg C
Read set temp, Ts deg C
SCC auto or manual ?
Auto
Manual
Ts set by user on SCC.
Read Ts from user-defined program, or new value set on SCC if adjusted by user.
Heat state ?
ON
OFF
Tr - Ts > 0.5 ?
Ts - Tr > 0.5 ?
N
N
Y
Y
Send OFF command to heater.
Send ON command to heater.
30
Any zones enabled ?
N
Switch all zones to ON
Y
Set n = 1 (n = zone number)
Zone(n) enabled ?
N
Y
Zone (n) required ?
N
Y
Set Zone-flag(n) = OFF
Set Zone-flag(n) = ON
n = n + 1
n > 4 ?
N
32
Set zones per Zone-flags.
Max fan speed adjusted by user ?
Y
Set max fan speed to user selection
N
Set max fan speed to sum of common zone + set fan speeds for zones=ON

Figure 3

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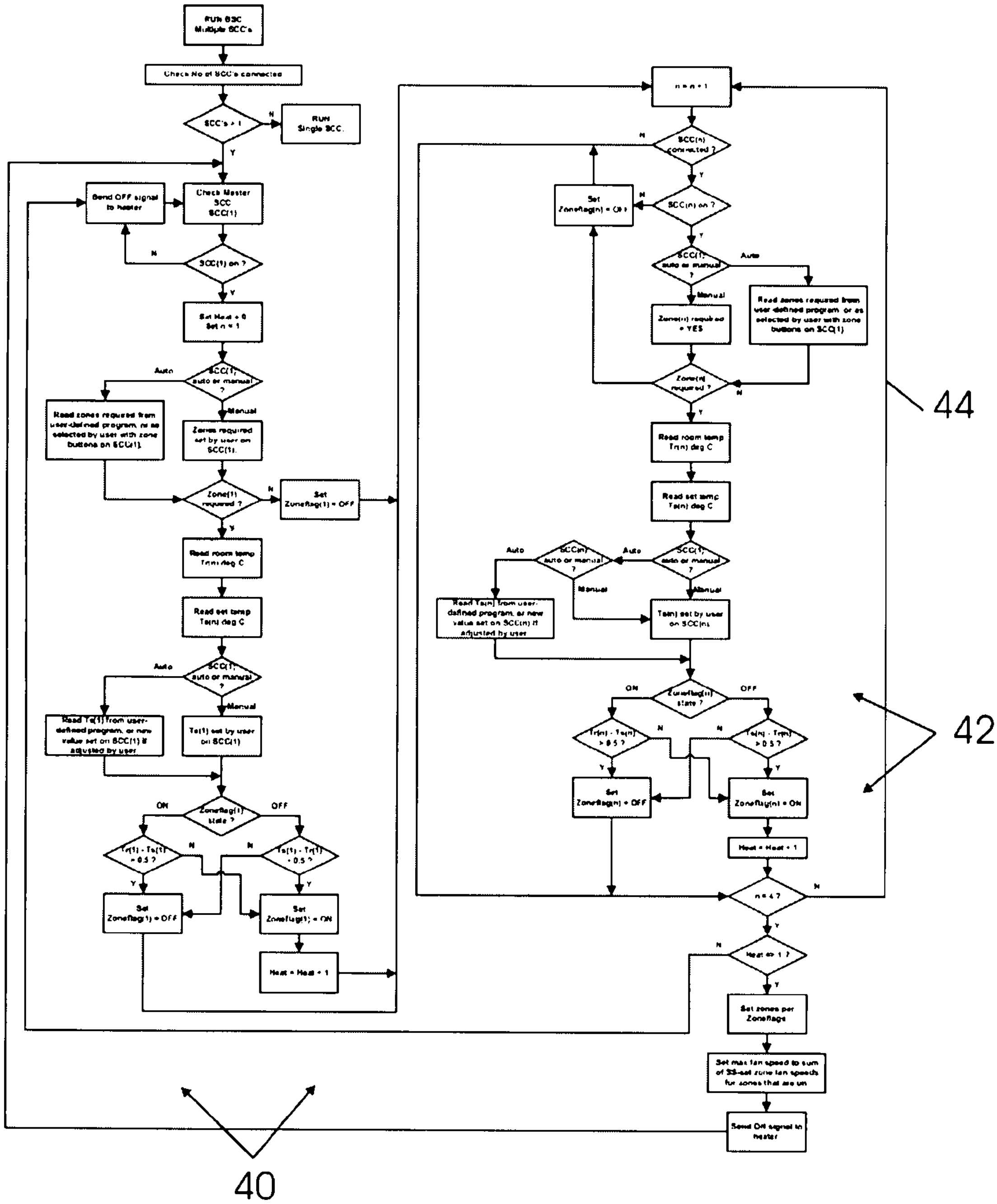

Figure 4